

Claims

[c1] What is claimed is:

1.A photodiode comprising,

(a)first ohmic contact layer;

(b)a semiconductor structure consisting of;

(i) a substrate;

(ii)a highly doped buffer layer, material-type same as the substrate;

(iii)a single or multiple layers of InGaAs with different contents for absorption layer;

(iv)a doped-thin layer of InGaAs;

(v)a highly doped-thick layer of InGaAs or combination of doped InAlAs and InGaAs layers for the second ohmic contact, and;

(c)second ohmic metal contact on the top of the thick-doped layer.

[c2] 2.The photodiode array comprises:

(a)NxN photodiodes, wherein each photodiode comprises,

(i)common ohmic metal contact layer on the backside of the substrate for all photodiodes in the array;

(ii)the said semiconductor structure as claimed in Claim

1; and

(iii)the said second ohmic- contact layer on the top of the highly doped-thick InGaAs layer as claimed in Claim 1, and;

(b)interconnection metal line, wherein each metal line is connecting each photodiode to the outside pad to make independently addressable.

[c3] 3. The said interconnection metal line as claimed in Claim 2, connects the photodiodes in a way that at a time only one photodiode signal can be taken out located in the same row and column.

[c4] 4. The said interconnection metal lines, as claimed in Claim 2, can be designed in a way that metal connection of each photodiode located one-fourth of the array are designed to align in two sides. Replica of this metal layout can be copied for metal connection alignment for other photodiodes located in the three-fourth of the array.

[c5] 5.The photodiode array comprises:

(c) $N \times N$ photodiodes, wherein each photodiode comprises,

(i)common ohmic contact layer;

(ii)a etch-off substrate to open for light illumination;

(iii)the said semiconductor structure as claimed in Claim

1; and;

(iv)the said second ohmic metal contact layer as claimed in Claim 1, on the top of the highly doped-thick InGaAs layer as claimed in Claim 1;

wherein said second ohmic contacts can be flip-chip bonded for independently addressable.

- [c6] 6. The said highly doped-thin layer of InGaAs, as claimed in Claim 1, is on the light illumination surface for the top-illumination type photodiode.
- [c7] 7. Said highly doped-thick layer of InGaAs, as claimed in Claim 1, could be single high-doped InAlAs material or highly doped multiple (combination) layers of InAlAs and InGaAs.
- [c8] 8. In the case of single high-doped InAlAs layer or multiple (combination)high-doped InAlAs and high-doped InGaAs layers, as claimed in Claim 7, the graded layer is incorporated in the structure to reduce the resistance at the InAlAs-InGaAs band-edge discontinuity.
- [c9] 9. The said substrate type as claimed in Claim 1, is InP, or InGaAs, or GaAs.
- [c10] 10.The highly doped-thin InGaAs layer and highly doped-thick InGaAs layer, as claimed in Claim 1, can have the same or different level of doping.

[c11] 11. The fabrication process of the photodiode array of top-illumination type, comprises,

- (a)growing the layers forming the photodiode structure on the said substrate as claimed in Claim 1;
- (b)patterning and dry etching of highly doped thick layer of InGaAs, as claim in Claim 1, to open the illumination surface;
- (c)formation of the top ohmic contact;
- (d)patterning and dry-etching the diode structure to isolate from each other;
- (e)depositing the step coverage layer and planarization;
- (f)patterning and formation metal lines connecting the photodiode contact to the outside pad;
- (g)etch out the dielectric from the illumination surface;
- (h)polishing the substrate and formation of the common ohmic contact at the back side of the substrate, and;
- (i)formation of antireflection coating on the top of the surface.

[c12] 12. The metal lines, as claimed in Claim 11, can be made using the molding (like nano and micro level imprinting).

[c13] 13. The fabrication process of the photodiode array of bottom-illumination type, comprises,

- (a)growing the layers forming the photodiode structure on the said substrate as claimed in claim 1;

(b)patterning and formation of the top ohmic contact;
(c)patterning and dry-etching the diode structure to isolate from each other;
(d)depositing the step coverage layer and planarization;
(e)formation of the common ohmic contact at the back side of the substrate;
(f)etching-off back side of the substrate to open the illumination surface, and;
(g)formation of antireflection coating on the illumination surface.

[c14] 14. The AR coating as claimed in Claim 11 is single layer or multiple layers of metal oxides.

[c15] 15. The dry etching for isolating each photodiode element from each other, as claimed in Claim 11 is needed to etch out down to the intrinsic absorption layer or more bellow than that.

[c16] 16. The dry etching for isolating photodiode element from each other as claimed in claim 11 is needed to be etch out down to the surface of the said substrate or below than its surface.

[c17] 17. The fixed or tunable filter can be monolithically integrated on the photodiode, as claimed in Claim 1, to tune the wavelength as necessary.

[c18] 18. The fabrication process of single photodiode of top-illumination type, comprises,

- (a)growing the layers forming the photodiode structure on the substrate as claimed in claim 1;
- (b)patterning and dry etching of highly doped thick layer of InGaAs, as claim in Claim 1, to open the illumination surface;
- (c)formation of the top ohmic contact;
- (d)polishing the substrate to appropriate thickness and formation of the bottom ohmic contact, and;
- (e)formation antireflection coating on the top of the surface.

[c19] 19. The fabrication process of the single photodiode of bottom-illumination type, comprises,

- (a)growing the layers forming the photodiode structure on the said substrate as claimed in claim 1;
- (b)patterning and formation of the top ohmic contact;
- (c)formation of the common ohmic contact at the back side of the substrate;
- (d) etching-off back side of the substrate to open the illumination light surface, and;
- formation of antireflection coating on the bottom light illumination surface.

[c20] 20. Single tunable filter or combination of fixed filters

can be integrated with the Photodiode array, as claimed in Claim 19 to filter the wavelengths spatially along the arrays.